What I claim as my invention is:

1. A quantum optical measurement apparatus for determining an optical characteristic of an optical element comprising:

an entangled photon source in optical communication with the optical element to be measured, said entangled photon source generating a plurality of photon pairs (twinons), each of said twinons comprising a first twin photon and a second twin photon, said first twin photon being correlated to said second twin photon in at least one of time, wavelength and polarization;

a first beamsplitter element in optical communication with said optical element to be measured, said beamsplitter element providing a first optical path and a second optical path for said twinons;

a second beamsplitter element, along said first optical path, in optical communication with said first beamsplitter element, said second beamsplitter element providing a first optical branch and a second optical branch for said twinons;

a variable optical delay element simultaneously in both the first and second optical branches, wherein there is an additional predetermined fixed delay between the first and second optical branches, wherein also said variable optical delay element is controlled by an external signal;

a plurality of first detectors in optical communication with said second beamsplitter element, each of said first detectors adapted to receive photons in one of said optical branches; and

a second detector in optical communication with said first beamsplitter element along said second optical path,

wherein each of said plurality of first detectors and said second detector is preceded by an optical polarizer, said polarizers being oriented at 45 degrees to the polarization axes of said twinons.

2. The quantum optical measurement apparatus of claim 1 further comprising a electronic processing unit in communication with said plurality of first detectors and said second detector.

3. The quantum optical measurement apparatus of claim 2 wherein said processing unit is adapted to identify coincident photon detections in said second detector, said coincident detections being photon detections in said second detector that occur within a pre-determined time window before or after a photon detection in one of said plurality of first detectors.

4. The quantum optical measurement apparatus of claim 3 wherein said processor is adapted to generate a rate of coincidence detections for each of said plurality of first detectors.

5. The quantum optical measurement apparatus of claim 4 wherein said processor is further adapted to adjust the delay of the variable optical delay element in accordance with a predetermined program.

6. The electronic processor of claim 5 wherein the predetermined program includes the steps of identifying the delay of the variable optical delay element for which the rate of coincident detections is substantially equal for all of said plurality of first detectors.

7. The electronic processor of claim 6 wherein the predetermined program further includes the step of adjusting the delay of the variable optical delay element to maintain the substantially equal rate of coincident detections for all of said plurality of first detectors.

8. A quantum optical apparatus for compensating an optical characteristic of an optical element comprising:

a beam multiplexer in optical communication with an entrance aperture of said optical element, said beam multiplexer comprising a first input aperture, a second input aperture, and an output aperture;

an entangled photon source in optical communication with said first input aperture, said entangled photon source generating a plurality of photon pairs (twinons), each of said twinons comprising a first twin photon and a second twin photon, said first twin photon being correlated to said second twin photon in at least one of time, wavelength and polarization;

a beam divider in optical communication with an output aperture of said optical element, said beam divider comprising an input aperture, a first output aperture and a second output aperture, said first output aperture defining a twinon optical path and said second output aperture defining a signal output path;

said twinon optical path further comprising:

a first beamsplitter element, located in said twinon optical path, said beamsplitter element in optical communication with said first output aperture of said beam divider, said beamsplitter element providing a reference optical path and a variable delay optical path for said twinons;

a second beamsplitter element, along said variable delay optical path, in optical communication with said first beamsplitter element, said second beamsplitter element providing a first optical branch and a second optical branch for said twinons;

a variable optical delay element simultaneously in both the first and second optical branches, wherein there is an additional predetermined fixed delay between the first and second optical branches, wherein said variable optical delay element is controlled by an external signal;

a plurality of first detectors in optical communication with said variable delay element, each of said first detectors adapted to receive photons in one of said optical branches after the variable optical delay element; and

a second detector in optical communication with said first beamsplitter element along said second optical path;

wherein each of said plurality of first detectors and said second detector is preceded by an optical polarizer, said polarizers being oriented at 45 degrees to the polarization axes of said twinons, and

said signal optical path further comprising:

a second variable optical delay element, the delay of said second variable optical delay element being controlled by an external signal;

wherein an optical communications signal input to the second input aperture of said beam combiner propagates sequentially through said optical element, said beam divider, and said second variable optical delay element.

9. The quantum optical apparatus of claim 8 wherein said processing unit is adapted to identify coincident photon detections in said second detector, said coincident detections being photon detections in said second detector that occur within a pre-determined time window before or after a photon detection in one of said plurality of first detectors.

10. The quantum optical apparatus of claim 9 wherein said processor is adapted to generate a rate of coincidence detections for each of said plurality of first detectors.

11. The quantum optical apparatus of claim 9 wherein said processor is further adapted to adjust the delay of said first and said second variable optical delay elements with control signals, in accordance with a predetermined program.

12. The electronic processor of claim 11 wherein the predetermined program includes the steps of identifying the delay of the variable optical delay module for which the rate of coincident detections is substantially equal for all of said plurality of first detectors.

13. The electronic processor of claim 12 wherein the predetermined program further includes the step of adjusting the delay of said first variable optical delay module to maintain the substantially equal rate of coincident detections for all of said plurality of first detectors.

14. The electronic processor of claim 12 wherein the predetermined program further includes the step of adjusting the delay of said second variable optical delay module to counteract the identified delay.

15. The quantum optical apparatus of claim 8 wherein said second variable optical delay element and said first variable optical delay element are mechanically connected and controlled thereby by a single control signal.

16. The quantum optical apparatus of claim 8 wherein said second variable optical delay element and said first variable optical delay element are embodied in a single variable optical delay element.

17. The variable optical delay element of claim 16 comprising a first optical path, a second optical path and a third optical path wherein the delay in the three optical paths have a predetermined relationship, said relationship being preferably linear.

18. A quantum optical measurement method for determining an optical characteristic of an optical element comprising the steps of:

a first step of transmitting a twinon beam through said optical element;

a second step of dividing the twinon beam exiting said optical element into a reference arm and a variable arm, said second step further including dividing said variable arm into a first branch and a second branch, wherein said reference arm and said variable arm are arms of a Quantum Interference Device;

a third step comprising applying a variable polarization- or wavelength-specific delay to said two branches of the variable arm, wherein the two branches also have a fixed delay offset between them;

a fourth step of measuring the coincident photon detection rate between said reference arm and said variable arm, wherein the variable delay is adjusted until the coincident detection rate between said two branches of the variable arm and the reference arm are equal and significantly higher or lower than the CD rate for uncorrelated twinons; and

a fifth step whereby the CD rates are monitored, said step further including adjusting the variable delay to maintain equal CD rates for the twinons in the two branches of the reference arm..

19. A quantum optical compensation method for correcting the effect an optical characteristic of an optical element on an optical communications signal comprising the steps of:

a first step of transmitting a multiplexed twinon beam and an optical communications signal through said optical element;

a second step of demultiplexing said communications signal and said twinon beam, said second step further comprising dividing the twinon beam exiting said optical element into a reference arm and a variable arm, said second step further including dividing said variable arm into a first branches and a second branch, wherein said reference arm and said variable arm are arms of a Quantum Interference Device;

a third step comprising applying a variable polarization- or wavelength-specific delay to said two branches of the variable arm, wherein the two branches also have a fixed delay offset between them;

a fourth step of measuring the coincident photon detection rate between said reference arm and said variable arm, wherein the variable delay is adjusted until the coincident detection rate between said two branches of the variable arm and the reference arm are equal and significantly higher or lower than the CD rate for uncorrelated twinons;

a fifth step of applying a variable optical delay to said optical communications signal, wherein the value of said delay is determined from the delay measured in said twinon beam; and

a sixth step whereby the CD rates are monitored, said step further including adjusting the variable delay to maintain equal CD rates for the twinons in the two branches of the reference arm and the delay in the signal beam VDE being correspondingly adjusted.